Clinical Accuracy of a Patient-Specific Guide for Delivering a Planned Femoral Neck Osteotomy

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Introduction

The primary purpose of Total Hip Arthroplasty (THA), aside from pain relief, is to restore hip biomechanics such that the patient experiences no discernible functional deficit, while also providing an environment conducive to implant longevity. Key factors in determining a successful THA include achieving the desired pre-operative femoral offset and leg length, as well as the restoration of range of motion (ROM). Minor leg length discrepancies (LLDs), less than a centimetre, are common after THA and usually well tolerated. However, in some patients, even these small discrepancies are a source of dissatisfaction. More significant discrepancies can be a risk factor for more serious concerns such as nerve injury, abnormal gait and chronic pain. The level of the femoral neck osteotomy is a critical step in reproducing a planned femoral stem position. Frequently the femoral osteotomy is too high and can lead to an increase in leg length and varus stem positioning. If the desired implant positions are identified from preoperative 3D templating, a planned femoral osteotomy can be used as a reference to recreate the correct leg length and offset. The aim of this study was assess the accuracy of a 3D printed patient-specific guide for delivering a pre-planned femoral neck osteotomy.

Methodology

A consecutive series of 33 patients, from two surgeons at a single institution, were sent for Trinity OPS pre-operative planning (Optimized Ortho, Australia). Trinity OPS is a pre-operative, dynamic, patient-specific modelling system for acetabular and femoral implant positioning. The system requires a pre-operative CT scan which allows patient specific implant sizing as well as positioning. Once the preoperative implant positioning plan was confirmed by the surgeon, a patient-specific guide was designed and printed to enable the planned level of femoral neck osteotomy to be achieved, Fig 1.

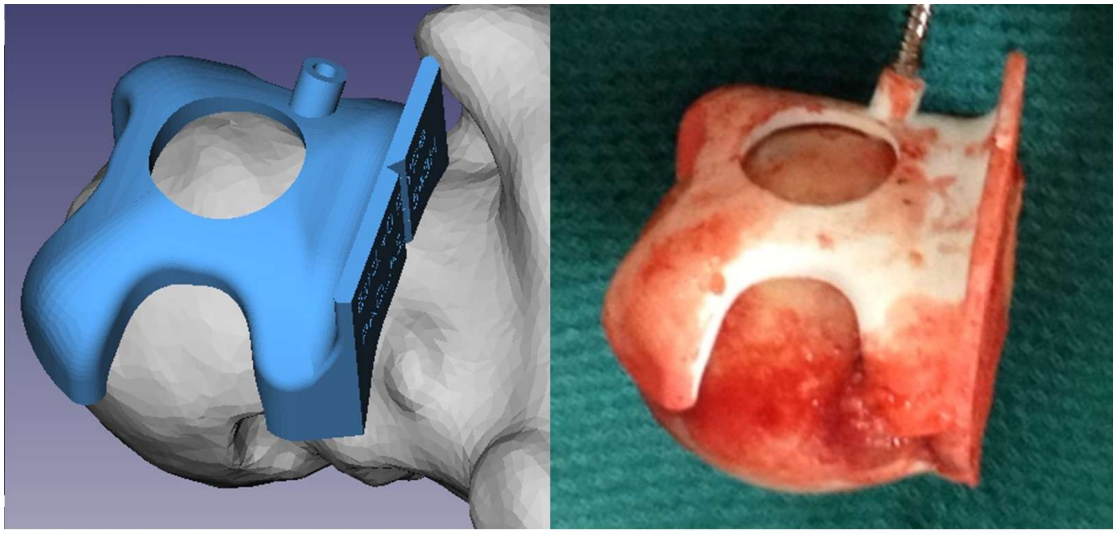

Fig 1. The design of the patient-specific guide used to achieve a planned femoral neck osteotomy

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All patients received a Trinity cementless acetabular component (Corin, UK) and a cementless TriFit TS femoral component (Corin, UK) through a posterior approach. The achieved level of osteotomy was confirmed postoperatively by doing a 3D/2D registration, in the Mimics X-ray Module (Materialise, Belgium), of the planned 3D resected femur to the postoperative AP radiograph, Fig 2. The image was then scaled and the difference between the planned and achieved level of osteotomy was measured (imatri Medical, South Africa), Fig 2.

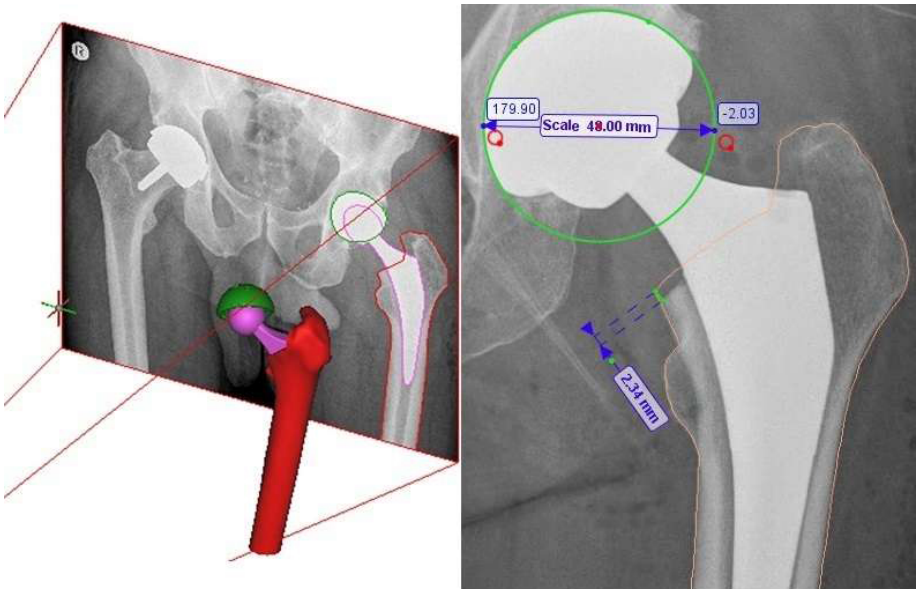

Fig 2. The achieve level of osteotomy was confirmed postoperatively by doing a 3D/2D registration of the planned 3D resected femur to the postoperative AP radiograph. The image was then scaled and the difference between the planned and achieved level of osteotomy could be measured.

Results

The mean absolute difference between the planned and achieved osteotomy level was 0.7mm (range 0.1mm – 6.6mm). Only 1 patient had a difference of more than 3mm, Fig 3. Of the 33 patients, 28 had a difference of less than 1mm.

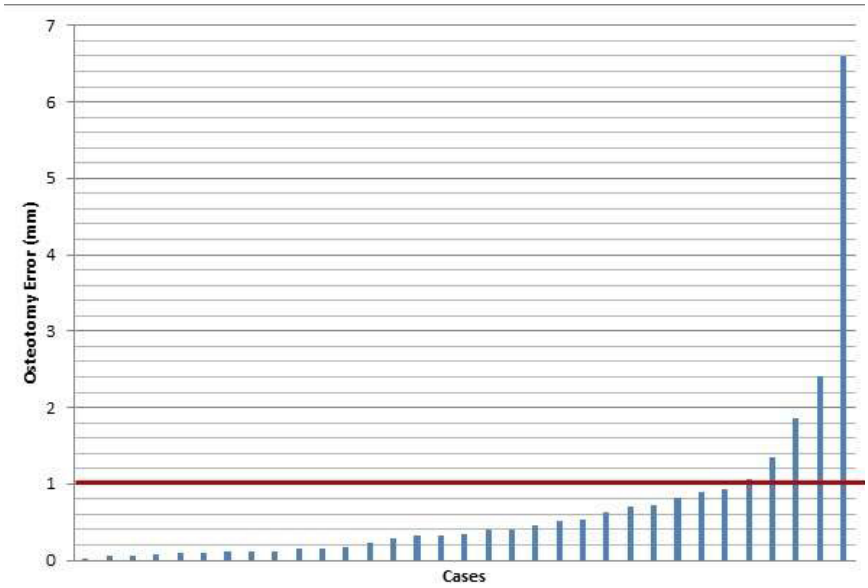

Fig 3. The absolute error in osteotomy level for all 33 patients

Conclusions

The results from this initial series of 33 patients suggest that a 3D printed patient-specific guide can be a simple and accurate way of intraoperatively reproducing a planned femoral neck osteotomy, though there was one significant outlier. Whether the 3D planning, patient-specific guide and accurate femoral osteotomy can then be used to achieve precise leg length and offset recreation is the subject of an on-going evaluation.